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CONTENTS

CHAPTER Page

I. INTRODUCTION, Summary of the Literature and the Problem 36

II. THE EXPERIMENT 45
- Subjects 45
- Materials 45
- Apparatus 48
- Procedure 48

III. THE DATA AND RESULTS 51
- Learning Data 51
- Test Data 52
- Results 53
- Summary of Results 64

IV. THE DISCUSSION 66
- Summary 86

BIBLIOGRAPHY 88

AN EXPERIMENTAL STUDY OF PSYCHOLOGICAL STIMULUS-RESPONSE

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CHAPTER I—INTRODUCTION

Although most psychologists agree that the stimulus-response conception is an essential feature of experimental psychology, a review of recent literature reveals considerable confusion concerning the interpretation of this basic phenomenon. While most workers appear to content themselves with an all too willing acceptance of gross approximations of the stimulus-response variables, others have indulged in physical analogies and other oblique interpretations of the phenomenon, and some psychologists have expressed keen dissatisfaction with the formula, insisting that we must relegate the stimulus to an incidental position in psychological events.

One has only to recall the many experiments reported in which an object has been used as a constant stimulus and the kind of reaction made to it recorded without regard to the kind of stimulating function really involved. Pictures, objects, animals, drugs, sounds, etc. have been employed with little or no regard for the antecedent and historical influence which these objects have had on the responses of the individual subject. Here the genetic aspects of behavior are generally not connected with stimulus-response happenings. In such cases the stimuli are unanalyzed and the responses described with an inadequate orientation to the complex behavior situation.

In the Topological Psychology of the Gestaltists (44, 45) are found momentary descriptions of field forces in terms of physical analogies. Geometric descriptions tend to detract from the realization that psychology has actually to deal with highly involved organisms adjusting to complicated civilizational situations that must be described as something more than psychical analogies to physical energies (30). After such descriptions are made the basic questions of stimulus-response remain unanswered. For in-

stance, in the case of two children, one of which is attracted to and the other frightened by a dog, how do such objects come by their power of attraction and repulsion? It is suggested that the answer to this question lies in the obvious fact that the given psychological happening is a phase of the subject's historically continuative behavior.

Perhaps the above objections are the basis for the discontent expressed by such writers as Woodworth, Thurstone, and Klüver. Woodworth (71) and Thurstone (62, 63) who have emphasized the dynamic character of the organism, stress inner drives to a degree that eliminates the stimulus-response formula as a useful concept. Woodworth insists on minimizing the importance of the stimulus as an experimental variable. To Thurstone the stimulus is an outmoded and overworked academic factor that must be dethroned if the datum of psychology (vitality of the organism) is to be scientifically studied. More significantly, Klüver (35), working in the animal field where stimulus-response is usually thought to be strongly entrenched, says that "we must dispose of the stimulus-response formula, since it is not only misleading and incorrect but harmful."

Kantor (29) has the opinion that Woodworth and Thurstone are entirely correct in objecting to so mechanical a notion of stimulus-response as is usually held and that Klüver's "fundamental mechanism" with which he would replace the stimulus-response conception is really a more adequate notion of stimulus-response than anything else. The difficulty seems to be that stimulus-response means different things to different writers. In spite of these and other differences stimulus-response appears to be indispensable to experimental psychology and it is our concern here to seek a more adequate definition and understanding of the stimulus-response formula. The terms have certainly not been used with precision and require rigorous and definitive investigation.

Before going further we might well consider some of the current notions of stimulus-response in light of the judicious attitude formulated by Mach (47) and developed by Henri Poincaré (55) and Bridgman (8). These writers call attention to the influence of preconceived notions, some of them theological, upon the ideology of science and urge a rigorously critical attitude toward the basic postulates of science.

A. The acceptance of light and air waves, pressure, etc. as stimuli correlated with psychological responses via the nervous system (which stood in an assumed one-to-one relation with the psyche or mind) was the earliest stimulus-

response concept in modern psychology and is still employed in various guises. The present forms of this interpretation usually emphasize the response as essentially a neural process correlated with a psychic or conscious activity as in the traditional psychophysics. In criticism of this interpretation of the response we point to the various researches on neural extirpation which have discredited explanation of responses in terms of specific neural pathways and called into question the emphasis usually given the nervous system. It is significant that biologists are more and more emphasizing the organism as a whole and regarding the nervous system as having no priority in importance over other physiological systems. On the stimulus side we discover lack of exact correlation between such stimuli and discrimination responses. For instance, orange discrimination can be correlated with a single wave-length or a combination of two wave-lengths while purple discrimination cannot be correlated with any one wave-length. The laws of color mixture, adaptation, after-image, contrast and twilight vision all proclaim that "red" light does not always yield the "sensation" red and "sensation" red is not always the result of red light.

B. The stimulus-response school of behaviorism has variously regarded crude objects and situations as stimuli correlated with neuro-muscular or neuro-glandular responses. This notion of stimuli meets with the objection of being only a first approximation to an adequate conception of psychological stimulus and is more methodological than scientifically descriptive. For example, if an object be regarded as a stimulus constant we can only observe the general type and time of the response made. Concerning the responses it would appear that the concept provides for only a partial description of the behaving organism. Warren (67) in his criticism of "radical behavioristic psychology" has indicated the inadequacy of regarding response as exclusively a process beginning with the physiological operation of an end organ and ending with a process in a neuro-muscular event.

C. In the dynamic type of conception the stimulus is regarded as an occasion for a response and the response as so much energy released to satisfy some inner drive or purpose. Psychological responses are thought of as coming from inner processes in the organism with stimuli bearing simple causative relations to responses. There are two main views of this conception. The first (Thurstone 62, 63) assumes that drives are either powers of some sort, in which case stimuli are superfluous, or, that they are actual response

equipments (desires, interests, purposes, etc.) to be set in operation by less potent energies (stimuli). The second (Woodworth 71, 72) regards biological structure-functions as stimulating responses, i. e., the hunger or thirst drives are regarded as stimuli for eating and drinking responses. This latter view raises three pertinent questions as yet unanswerable: (1) would it not be better to regard hunger and thirst as stimuli rather than as drives? if so, the concept of stimulus loses its occasional aspect; (2) because of their periodicity do not hunger and thirst only seem to support the notion of stimulus as occasion?; and (3) is it reasonable to assume that there are physiological conditions numerous enough to be thought of as drives for the tremendously large number of psychological responses? Certainly this viewpoint presents a discouraging number of methodological problems to the stimulus-response conception of experimental psychology.

D. No doubt the view that gestalten or pattern stimuli are the correlates of complete body action responses is the most sophisticated interpretation so far considered here. One is impressed with the minute inclusiveness of each of the two variables of the formula. The stimulus, its field and ground have been subjected to the most elaborate analyses even to the point of wholesale applications of physical science techniques (Kantor 30). The concept of response has been carefully restricted to only observable phenomena without omitting any known features of biological activity. In spite of sheer bio-physical completeness the conception requires a third factor to complete its description of psychological behavior, namely, the phenomenological or unknowable factor of Gestalt Psychology. In consequence, workers (Klüver 35) in stimulus-response eventually are forced to fall back on descriptions of their results in terms of phenomenological or relatively unknowable properties of stimuli and phenomenological or relatively unknowable aspects of responses. Accordingly, our analysis here leads us directly to phenomenological processes. Boring (6) recently in a critical review of Koffka's Principles of Gestalt Psychology, has questioned the adequacy of that author's conception of psychological stimuli and inquired as to the nature and origin of such stimuli. Without objecting further it is pointed out that the phenomenological factor is probably the most recent variation of the mental processes of Act Psychology and that, as Kantor (29) has suggested, "it requires at least such emendation as Warren's (66) Double-Aspect hypothesis to bring it within the range of objective Theory."

E. Regarding the stimulus-response event as essentially a single behavioral happening with the stimulus and the response as mutually necessary functional features analyzed out for logical convenience, Organismic or Interactional Psychology (Kantor 27, 28, 29, 30, 31) emphasizes the interactional relationship between these two variables. The psychological stimulus is considered an action or function performed by a stimulus object corresponding to the action or function of the whole responding organism. A given interaction of these two variables is held to be dependent on the former interactions of the two, so that regardless of the physical properties of the stimulus object it takes on a particular stimulus-function which evokes a characteristic response to the object. The response is not conceived as a fixed or static configuration of bodily activity but as the functional adjustment of the whole organism to the stimulus-function. This view eschews descriptions of psychological stimulus-response exclusively in terms of physical properties and corresponding anatomical or physiological processes, holding that though such descriptions may be satisfactory for physiology and physics they are inadequate in any fundamental psychological sense. The main objection to this concept is that it is confined to a purely descriptive and analytic level in its approach to psychological problems. However, what it lacks in ready explanations appears to be due more to the limitations of our present knowledge than to any inherent defect. Moreover, it has the recommendation of avoiding over-simplified, teleological, mentalistic, and other scientifically fallacious implications, and of recognizing a psychology with its own unique field without relying on wholesale borrowings from its sister sciences.

Having critically reviewed the representative interpretations of stimulus-response phenomena current in psychology the writer is of the opinion expressed by Skinner (60), that any worthwhile concept of stimulus-response must be experimentally justified. This, in general, is the purpose of the present research. But before proceeding to a more specific statement of the problem it is well to consider some of the experimental literature which may be regarded as its background. This work may be divided into four general classes: (1) Experiments in "judgment time" of psychometric measures; (2) Certain studies in "transposition" or "transfer" phenomena; (3) Work on "equivalent stimulation"; and (4) Experimentation for stimulus-response descriptions.

(1). The time consumed in making discriminatory responses to objective differences between two or more stimu-

lus objects is a methodological problem in psychophysical experimentation. The findings of the following writers have some bearing on the analysis of the response variable in the stimulus-response formula. As Kellogg (32) in reviewing this literature has pointed out this particular problem has received scant experimental attention. In 1885 Merkel (50) required his subjects to react to a single stimulus with one key, then to two stimuli with two keys and so on up to ten stimuli with ten keys. He found a progressively longer reaction time accompanied corresponding increases in the number of possible responses. Henmon (22, 23) working in several sense modalities and using two stimuli and two response-keys found that the smaller the objective difference between the stimuli the slower the reaction time of discrimination, and that the dispersions of distribution of wrong reaction times tended to be greater than those for right reaction times. Attempting to relate reaction time to confidence, Seward (57) concluded that the accurate response was quicker than the more inaccurate response. In a recognition experiment with tactually presented 'closed' and 'open' Gestalt form patterns Rosenbloom (56) found that the 'closed' figures were recognized with a greater degree of accuracy and a faster reaction time than were 'open' figures. George (19) investigating judgments of sound intensities and visual extent found the average reaction time for the category 'less' was 0.88 sec., for category 'greater' 0.92 sec., for category 'equal' 1.10 sec., and for category 'doubtful' 1.42 sec. In a study of 'judgment-time' as it varied with objective differences between judged pairs of stimuli without the subject being aware that his time was being measured, Kellogg (32) found that decreases in objective difference between stimuli were accompanied by a corresponding increase in 'judgment-time.'

(2). The second class includes studies of 'transposition' and 'transfer' phenomena which serve to demonstrate that new and different stimulus objects appear to evoke a response previously established with a constant stimulus. As early as 1902 Kinnaman (33) presented *Mecacus rhesus* monkeys with food on the lighter of two adjacent grays in a lighter to darker scale of nine grays and reported a general notion of "food in the lighter" of any two of the grays. In 1918 Hunter (25) trained rats to discriminate between sound and silence and found some of the animals reacted correspondingly to substitutions of light and darkness. Watson and Watson (69) negatively conditioned a child to a rat and found without further training it made fear reactions to a

variety of furred objects. Köhler (36, pps. 216-217, 302, 303) in his 'transposition' experiments found that chickens trained to discriminate between medium gray when medium gray and light gray were presented, reacted to dark gray when dark and medium grays were presented. He obtained similar results with apes when they were presented with sizes and hues of colors. Gulliksen (21), McKinney (49), Yum (74), and Munn and Steining (52) have trained human subjects to react to constant geometric figures and found that they react similarly to quite a number of variations of the training material.

(3). The work on 'equivalent stimuli' may in general be said to have grown out of the work on "transposition" and "transfer" phenomena mentioned above and more specifically out of the experiments of Pavlov, Franz, and Lashley on 'brain mechanisms.' Pavlov (53), working with dogs, found what he called 'initial generalization,' namely, that there is a smaller excitatory effect with an increase of distance from the point of original stimulus corresponding to a diminished stimulational spread in cerebral areas. In a more recent critical repetition and revision of Pavlov's work, Loucks (46) found no evidence that the initial stimulation of more distant points resulted in more diminished responses (salivary secretions) than *loci* nearer to the originally conditioned place. Franz (18) trained subjects to identify given geometric forms when presented to given peripheral areas of the fovea and after learning found that the results were only slightly affected when these forms were presented to other peripheral areas equally distant from the fovea. On the assumption that learning involved large, dynamic neural connections rather than specific neural connections, Leeper and Leeper (43) presented one group of subjects with varying stimulational materials (mazes, melodies, rhythms) and the other with constant materials and found the rate of learning for varied and unvaried materials was roughly the same. Lashley (38) and Klüver (35) trained animals to respond to one stimulus which was replaced after learning by a different stimulus to determine whether the same reaction was produced. These studies attempted to determine in some detail the nature of the basic mechanisms of behavior and found that stimulus objects may be radically modified without affecting their 'equivalence.' The studies in this class are usually thought of as evidence for a correlation between physical stimulus configurations and corresponding neural configurations implied by the Gestalt stimulus-response interpretation.

(4). The fourth class of studies was made on the assumption that psychological stimulus-response involved dynamic behavior situations from which functional stimulus and response variables could be analyzed out and described for scientific convenience as distinguished from the traditional attempts to force simplification of the data into physical properties of stimulus objects and neuro-physiology. Skinner (59, 60), working with rats, conducted a critical series of experiments on various aspects of 'reflex' (stimulus-response) phenomena and found strong support for regarding stimulus-response phenomena as a correlation of generic factors. This work found a changing relevancy of stimulational properties correlated with responses, and pointed to a need for experimental definition of stimulus-response. The writer (11) in a study preliminary to the present work attempted to arrive at a more adequate description of the psychological stimulus variable in terms of its stimulational function or value in behavioral situations. Contriving psychological stimulus-response situations between human subjects and geometric figures he found the learned figures could be progressively varied out to points at which the psychological stimuli failed to operate and back to points where they resumed their functions. These results appeared to support definition of the psychological stimulus variable as a stimulus-function rather than as a stimulus object.

THE PROBLEM AND EXPERIMENTAL APPROACH

The present study is an attempt towards further analysis of the fundamental mechanisms in human behavior for the purpose of developing a more adequate description of psychological stimulus-response phenomena. Whereas, other workers have sought the psychological stimulus in terms of stimulus objects or in terms of phenomenological properties and the responses as functions of physiological systems or phenomenological activities, we begin with some convenient unit of psychological behavior and from this datum attempt an analytic description of the behavioral factors involved.

To this end such previous experimental techniques as were adaptable to our problem were considered with the following results: (1) geometric figures that could be varied conveniently were chosen because they would provide a basis for comparing results with related investigations such as Klüver's (35) experiments on equivalent stimuli, Gulliksen's (21) studies of 'transfer of response,' and previous work by the writer (11); (2) reaction time measurements were decided upon because it was felt that these would afford a

means of analyzing the response variable hitherto neglected in this type of work; and (3) a three-category type of response was selected because of the mechanical requirements of the materials selected.

With these techniques decided upon stimulus-response phenomena were contrived in the laboratory. Human subjects and carefully prepared stimulus figures unfamiliar to the subjects were brought together under controlled conditions of behavior so that prescribed psychological stimulus-response mechanisms could be set up and the following aspects of the coordinations investigated as they were being evolved and subsequently manipulated: (1) the number of presentations of the stimulus figures necessary to establish the prescribed stimulus-response events; (2) the extent to which the several stimulus figures could be modified before the established coordinations broke down; and (3) the effects of several experiential intervals on the breakdown points of the established phenomena. As a corollary investigation we attempted to determine whether or not there were any significant variations in the time of response in given stimulus-response situations during the above procedures.

CHAPTER II—THE EXPERIMENT

The present investigation was divided into three experimental situations as follows:

1. A Learning situation in which constant stimulus figures were presented to the subjects.
2. A Control situation in which extraneous figures were introduced among the figures used in the Learning situation.
3. A Test situation in which the figures used in the Learning situation and gradient variations of these figures were presented.

THE SUBJECTS

Three main groups of subjects designated as Group C, D, and E were used. Groups A and B were employed for preliminary and exploratory purposes and hence are omitted from further discussion. Fifty-seven subjects successfully participated in Group C and fifty-nine in Group D. Group E contained three sub-groups of subjects who had previously participated in Groups C and D and repeated the Test situation under the following conditions: (1) In Sub-group E^0 14 subjects from Group C and 16 from Group D repeated the Test situation a few seconds after their initial Test situation performance; (2) Sub-group E^1 represents 40 subjects, 12 from Group C and 28 from Group D, who repeated the Test situation from 1 to 10 weeks after their initial experience; and (3) The subjects in Sub-group E^2, the same as those participating in Sub-group E^1, repeated the Learning, Control and Test situations immediately following the Test situation of Sub-group E^1. The three experimental situations (Learning, Control and Test) operated in all groups except C. In this group the Control situation was not employed. All subjects were Indiana University students. Those in Groups C and D were unfamiliar with the purpose and nature of the experiment.

THE MATERIALS

Three sets of geometric figures corresponding to the three experimental situations described above were used. The Learning set consisted of four pairs of opposite figures half of which were arbitrarily designated as "right" figures and the other half, mirror images of these, as "left" figures, e. g.,

Figures 1 & 1', 2 & 2', 3 & 3', and 4 & 4' (see Plate I). The Control set contained the eight figures of the Learning set and four additional pairs of mirror figures (see Plate II). The Test set consisted of the eight figures of the Learning set and nine gradient variations of these figures (see Plate III).

PLATE I - FIGURES OF LEARNING SET

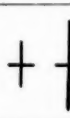
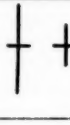
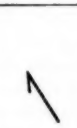
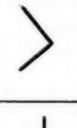
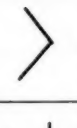
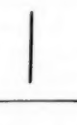
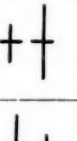
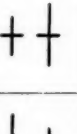
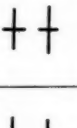
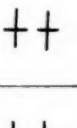
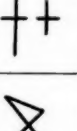
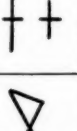
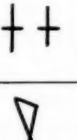
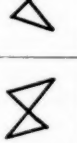
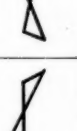
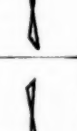
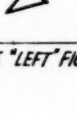
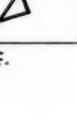
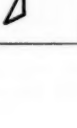
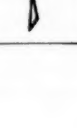
FIGURES NO.	1	2	3	4
RIGHT FIGURES				
LEFT FIGURES				

PLATE II - EXTRANEOUS FIGURES OF CONTROL SET

FIGURES	A	B	C	D
FIGURES	A'	B'	C'	D'

The figures were drawn in black India ink on a belt of kymograph paper 1358mm. long and 147mm. wide. Each figure occupied a field 25 by 29.5mm. with 9mm. space intervals between adjacent fields. The belt contained three lengthwise rows of 40 figures each, in the case of Group C, and four lengthwise rows of 40 figures each in the case of Groups D and E. The top row contained the four pairs of opposite figures of the Learning set, reproduced five times in a chance order as follows:

PLATE III - FIGURES OF TEST SET

VARIATIONS	→	0	3	7	9
90° ANGLES OF 12 mm. STEMS AND 4 mm VARIABLES WITH ANGLE REDUCED IN 9 STEPS OF 8° to 18°	FIG. NO. ▼ 1				
	1'				
54° ANGLES OF 2 13 mm. LINES EXPANDED IN 9 STEPS OF 14° EACH TO 180°	2				
	2'				
SMALLER CROSS - 10 mm. PERPENDICULAR LINE BISECTED WITH 4 mm LINE LARGER CROSS - 19 mm. PERPENDICULAR LINE BISECTED WITH 4 mm. LINE AND REDUCED IN 9 STEPS OF 1 mm EACH TO 10 mm	3				
	3'				
2 ADJACENT ANGLES OF 80° EACH REDUCED TO 8° ANGLES IN 9 STEPS OF 8° EACH. LONG LINE OF 23 mm AND SHORT LINE OF 12 mm.	4				
	4'				

* 'AFTER FIGURE DENOTES "LEFT" FIGURE.

1, 2', 3, 4', 1', 2, 3', 4, 2, 1', 4, 3', 2', 4', 3, 1, 4, 2, 1', 3', 1, 2', 3, 4', 3, 1', 2, 4', 2', 1, 3', 4, 1, 3', 2, 4', 1', 3, 4, and 2' (' indicates "left" figures). The Control set occupied the bottom row and contained the eight figures of the Learning set presented three times and eight Control figures presented twice in the following order: 1, b', c, 4', a', 2, 3', d, 2, 1', 4, c', b', d', 3, a, 4, b, 1', 3', 1, 2', c, d', 3, a', b, 4', 2', a, c', 4, 1, 3', 2, 4', 1', 3, 4, 2' (' indicates "left" figures). The two middle rows contained the Test set in which all eight figures of the Learning set and their nine variations were presented in the following chance order: 1-0', 2-4, 3-9', 4-1, 1-8, 2-5', 3-2, 4-6', 2-0', 1-3, 4-2', 3-6, 2-7, 4-5, 3-2', 1-7', 4-6, 2-1, 1-4', 3-3', 1-4, 2-3', 3-5, 4-8', 3-6', 1-8', 2-0, 4-9, 2-1', 1-7, 3-8, 4-5', 1-3', 3-3, 2-9', 4-2, 1-1, 3-7', 4-4', 2-9, 4-0, 2-7', 3-1, 1-5', 1-6, 2-6, 3-4', 4-1', 2-6', 1-2', 4-7, 3-9, 2-2, 4-0', 3-1', 1-2, 4-7', 2-8, 1-9', 3-4, 1-5, 2-2', 3-8', 4-4, 3-0', 1-9, 2-5, 4-3', 2-8', 1-1', 3-7, 4-3, 1-0, 3-5', 2-4', 4-8, 1-6', 3-0, 4-9', and 2-3 (the first numeral of each pair of two digit numbers designates the figure number, the second numeral indicates the variation number and ' signifies a "left" figure).

THE APPARATUS

A special presentation apparatus, previously described (Carter 13), was constructed to meet the following requirements:

1. Present several figures, one at a time, to the subject.
2. Hold the time of exposure and the time between exposure of figures constant for all presentations.
3. Permit each series of figures to be long enough for the employment of an effective chance order.
4. Preserve the exposed series of figures in the same order ready for presentation again.
5. Determine automatically the warning given the subject when an incorrect response was made or when the response movements were not made within required time limits.
6. Measure the reaction time of the subjects in sixtieth seconds and indicate the nature of the Learning and Test responses in each stimulus-response event.

THE PROCEDURE

In all Groups a room darkened enough for our purposes was used.

Except for the omission in Group C of the Control situation previously mentioned and for some slight differences in the trial periods and the instructions of the two groups the experimental procedure was the same for Groups C and D.

In these two groups the subjects were seated before the presentation apparatus and given the following printed outline:

An outline of what you are to do

1. Read the 'Instructions' CAREFULLY.
2. You will have a five minute trial period in which to find out how the apparatus works and what you are to do.
3. After the trial period you will reread the 'Instructions' CAREFULLY and ask any necessary questions.
4. Then, you will begin learning the proper responses to the figures according to the instructions.

Having read this the subject was handed the following:

'Instructions'

Through the hooded opening you will see some figures presented one at a time. After each figure you will hear a 'buzz' in the earphones until you learn to make the correct response for each figure.

There are only eight different figures (e. g., each member of a given pair is just the opposite in appearance to the other member of the pair).

The correct response to half the figures (one member of each pair of opposites) is made by *quickly* moving the response-lever all the way to the right, these are called the 'right' figures. The correct response to the other half requires you to quickly move the response-lever all the way to the left, these are called the 'left' figures. You will learn this only by trial and error; you cannot tell which way you are to move the lever the first time you see a figure. When you move the response-lever in a direction (right or left) that eliminates the 'buzz' you have made a correct response. If you hear a 'buzz' when the lever is moved you have made an incorrect response.

Your task is: first, to learn which are 'right' and which are 'left' figures; second, to learn to respond correctly and as quickly as you can to these 'right' and 'left' figures.

When the response-lever is moved, hold it in position for about 2 seconds and then return it to the central position by the time the 'knock' in the box is heard. If the lever is not moved quickly enough, or, if it is returned too quickly to the center, you will hear a 'buzz.'

Learn to respond to each individual figure. It is impossible to learn them in any order.

The instructions were then repeated verbally in the same language as that written and the subject shown just what he was to do.

After the trial period (3 minutes in Group C and 5 in Group D) the subject was again given the printed instructions and allowed to ask any necessary questions. Following this the Learning situation began and continued until the subject satisfied the learning criteria of three successively correct responses to each figure, or, until the learning time limit expired.

When the Learning situation was terminated the subject was given the following printed instructions which introduced the Control situation (not operative in Group C):

> You will now be tested to make sure you have learned to respond to all eight figures.
>
> Figures different from those learned will be presented along with those you have just been learning. You will respond to any figure you do not recognize as a 'right' or 'left' figure by pressing the small key located just above the response-lever and on top of the response-lever housing, and, to all 'right' and 'left' figures in the same way you have just learned to do.
>
> Do your best to respond as ACCURATELY and as QUICKLY as you can.

This Control situation continued until the subject revealed a satisfactory adaptation to the non-recognition way of responding (responding with the response-key located on top of the response-lever housing). He was then introduced to the Test situation with the following:

Final Instructions

> In the final trials that follow you will respond to all 'right' and 'left' figures in the same way you have just learned to do.
>
> All figures not recognized as 'right' or 'left' figures you will respond to by pressing the small key just above the response-lever and on top of the response-lever housing.
>
> It is important that you do your very best to respond as accurately and as quickly as you can. By all means you should avoid getting the 'buzz' for not moving quickly enough.
>
> Absolutely no questions can be asked nor any interruptions allowed.

All during the Learning, Control and Test situations the responses and reaction times of all subjects were recorded together with the experimenter's impressions of the subject.

CHAPTER III—THE DATA AND RESULTS

Although the data and results obtained in this study are presented through the media of group curves, averages, correlations, tables, etc. one should not lose sight of the need to consider the results of the individual subjects. The very nature of psychological problems requires that emphasis be placed on individual performances rather than on the statistical handling of group data. With this in mind we present our results statistically only for the purpose of convenient comparison and orientation.

Because the Control situation was introduced purely as a regulatory device in the transition between the Learning and Test situations, data from only these last two experimental situations are considered here, i.e., the Learning and Test Data.

THE LEARNING DATA

The raw data from the Learning series were recorded in a manner corresponding to the chance order of the figure presentations. Recorded were the two following types of responses and the reaction times of these responses: (1) Correct responses, or, those in which the subject responded to figures arbitrarily designated as right figures by moving the response-lever to the right and vice versa for left figures; (2) Wrong responses, or, those in which the subject responded to figures arbitrarily designated as right or left figures by moving the response-lever in a contrary direction.

Because of the chance order and bulk of the raw data it was necessary to transcribe, classify and summarize the Learning data from each subject into more workable form. The Learning data were divided into pre-learning, learning, and over-learning parts. The learning part consisted of the first three successive correct responses the subject made to any one figure. This was the learning criterion used. The pre-learning part refers to the responses made up to the point at which learning was considered to have occurred, and the over-learning part to the responses made after the criterion of learning was satisfied. The total number of responses and the total and average reaction times for correct, wrong, and both kinds of responses were tabulated for these three parts and for the whole learning series. This treatment was applied to the data from individual subjects only. Similar summaries were not obtained by groups of

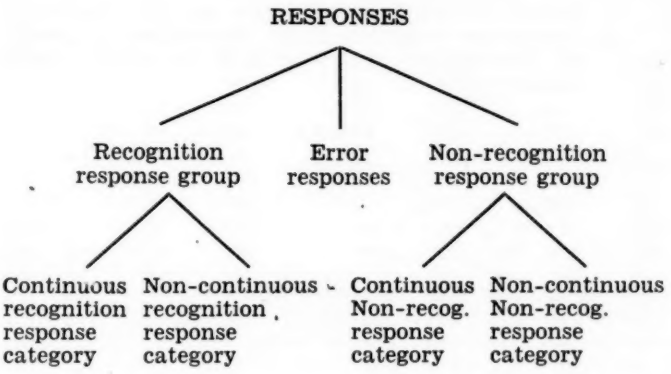
subjects as such results would have been superfluous in this investigation. The volume of the Learning results for individual subjects precludes presentation here. Later on the utility of the obtained computations will become apparent in the correlations between the individual subject's Learning and Test performances.

THE TEST DATA

For the same reasons given in the case of the Learning data, the Test data for each of the eight figures in Groups C, D and sub-groups, E^0, E^1, and E^2 were divided into Recognition (left responses to left figures and right responses to right figures), Non-recognition (response via non-recognition response-key) and Error (left responses to right figures and right responses for left figures) response groups. The Recognition response group was subdivided into two categories. First, the Continuous Recognition Response Category included the data from recognition responses made to a given original figure and to varying numbers of its nine variations without errors of response or interspersed non-recognition responses. Second, the Non-continuous Recognition Response Category included the data in which errors of response and interspersed non-recognition responses occurred before the last figure variation was responded to (Chart No. 1). In each of these two categories the responses to a given figure were classified according to the last figure variation number responded to, e.g., to the ninth figure variation, to the eighth figure variation, etc. on down to the class in which only the original figure was responded to. Similarly the Non-recognition response group was subdivided into two categories. First, the Continuous Non-recognition Response Category included the data from non-recognition responses made to varying numbers of a figure's nine variations without errors or interspersed recognition responses. Second, the Non-continuous Non-recognition Response Category contained the data for non-recognition responses interspersed with error and recognition responses. In each of these two non-recognition response categories the responses to a figure were grouped according to the first figure variation number responded to with a non-recognition response, e.g., to the original figure, to the first figure variation, second figure variation, etc. on down to the ninth figure variation (see Chart No. 1).

The Test data for Sub-group E^0 were divided into Recognition, Non-recognition and Error response groups only because the quantity of data did not justify further division.

Chart No. I



THE RESULTS

The above arrangements of the Learning and Test data permitted statistical treatment and analysis which gave the results described below.

1. *Internal consistency of the individual subject's responses in the Test situation*—Using a split-half technique of rank difference correlations between the number of recognition responses each subject made in the Test Situation to the originals and variations of figures number 1, 2, 3', and 4' and to those of figures number 1', 2', 3, and 4, the following results* were obtained:

Group C:	$r = .913$
Group D:	$r = .873$
Group E^1:	$r = .956$
Group E^2:	$r = .94$

These results indicate that the individual subject tended to occupy a unique and constant position in the given group of subjects.

2. *The relationship between the individual subject's responses in the Learning and Test situations*—Investigating for relationships between the Learning and Test series of responses Pearson's correlation technique was applied with the following results:

* Stepped up by the Spearman-Brown Prophecy Formula.

a. A slight and fairly consistent positive correlation was found between the percentage of correct responses in the Learning Series and the number of recognition responses in the Test Series for nearly all eight figures in Groups C, D, E^1, and E^2 as indicated below.

TABLE I

Groups

	C		D		E^1	E^2	
Figs.	r	P.E.	r	P.E.	r	r	P.E.
1	.399	.075	.323	.080	.187	.167	.104
1'	.239	.084	.300	.081	(for per cent correct scores in Learning Series of C and no. of recogni. responses in Test Series of E^1)	.272	.099
2	.175	.086	.257	.084		.289	.098
2'	.100	.088	—.074	.089		—.284	.098
3	.168	.087	.170	.086		.359	.093
3'	.002	.085	.210	.085		.334	.095
4	.388	.075	.327	.080	.369	.180	.103
4'	.199	.086	.059	.089	(for per cent correct scores in Learning Series of D and no. of recogni. responses in Test Series of E^2)	.135	.105

b. No significant relationship was found between the number of recognition responses in the Test Series and the number of pre-learning responses in the Learning Series as shown below.

TABLE II

Groups

	C		D		E^2	
Figs.	r	P.E.	r	P.E.	r	P.E.
1	—.127	.088	—.274	.081	—.168	.104
1'	—.022	.089	—.319	.079	—.001	.107
2	.042	.089	.092	.087	—.253	.100
2'	—.001	.089	.061	.087	—.115	.105
3	—.095	.088	—.186	.085	—.215	.102
3'	—.037	.089	—.167	.085	—.190	.103
4	—.145	.087	—.055	.088	.001	.107
4'	—.154	.087	—.051	.088	—.282	.098

c. No significant relationship was found between the number of recognition responses in the Test Series and the number of over-learning responses in the Learning Series as the results below indicate.

TABLE III

Groups

	C		D		E^2	
Figs.	r	P.E.	r	P.E.	r	P.E.
1	—.095	.089	—.134	.087	—.096	.106
1'	—.177	.087	—.144	.087	—.002	.107
2	—.166	.088	—.221	.084	—.179	.103
2'	.030	.089	—.122	.086	.134	.105
3	.000	.089	—.099	.087	—.153	.104
3'	—.019	.089	—.369	.076	—.037	.107
4	—.188	.086	—.149	.086	—.155	.104
4'	—.154	.087	—.134	.086	—.070	.106

d. The correlations between the number of recognition responses in the Test Series and the average reaction time for each subject in the Learning Series were likewise negligible as seen from the results below.

TABLE IV

Groups

	C		D		E^2	
Figs.	r	P.E.	r	P.E.	r	P.E.
1	—.024	.089	—.321	.079	.005	.107
1'	.115	.088	—.297	.080	—.098	.106
2	—.146	.087	—.154	.086	.242	.100
2'	.163	.087	—.001	.088	—.098	.106
3	.121	.088	.005	.088	—.414	.088
3'	—.001	.089	.002	.088	—.181	.103
4	.187	.086	—.093	.087	—.137	.105
4'	.002	.089	—.113	.087	.003	.107

These correlations suggest little or no correspondence between the individual subject's performance in the Learning Series and his subsequent performance in the Test Series for the relationships investigated.

3. *The percentages of recognition responses to each figure variation*—The percentages of recognition responses to each of the nine figure variations were computed for each of the two Test data categories, (e.g., the continuous and non-continuous recognition response categories) and for the two combined categories. These percentages were derived by dividing the total number of possible responses to a given figure variation by the actual number of recognition responses made to that variation, so that the percentage of

responses to each gradient variation of a figure or to comparable variations of several figures was obtained. These percentages were found for:

a. Each of the eight figures in Groups C, D, E^1, and E^2. (See Plate IV)
b. Each of the four groups of subjects, e.g., C, D, E^1, and E^2. (See Plate V)
c. All groups, C + D + E^1 + E^2 combined. (See Plate V)

Considerable correspondence was found between the curves for each pair of opposite figures, for the same figure in each group, and for curves representing each group. The curve representing the non-continuous recognition response

PLATE IV

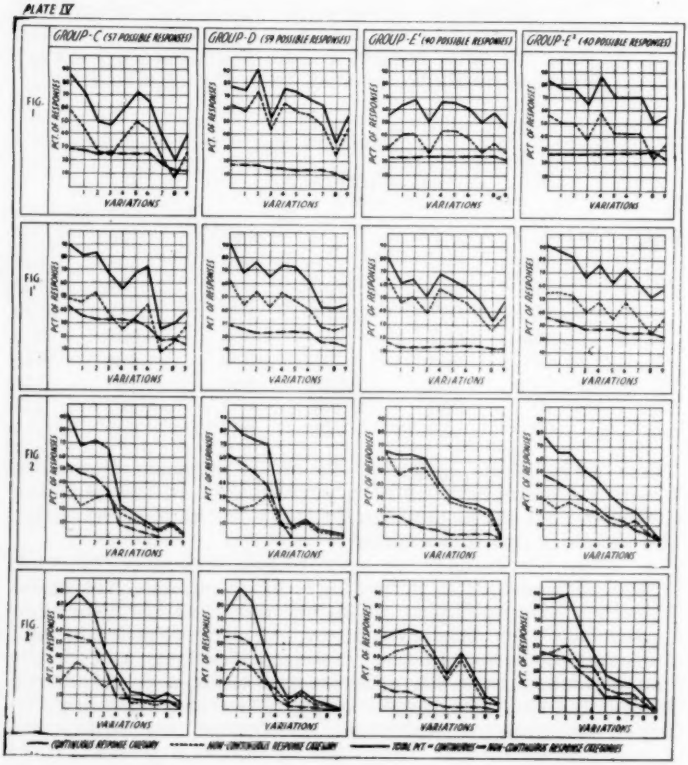
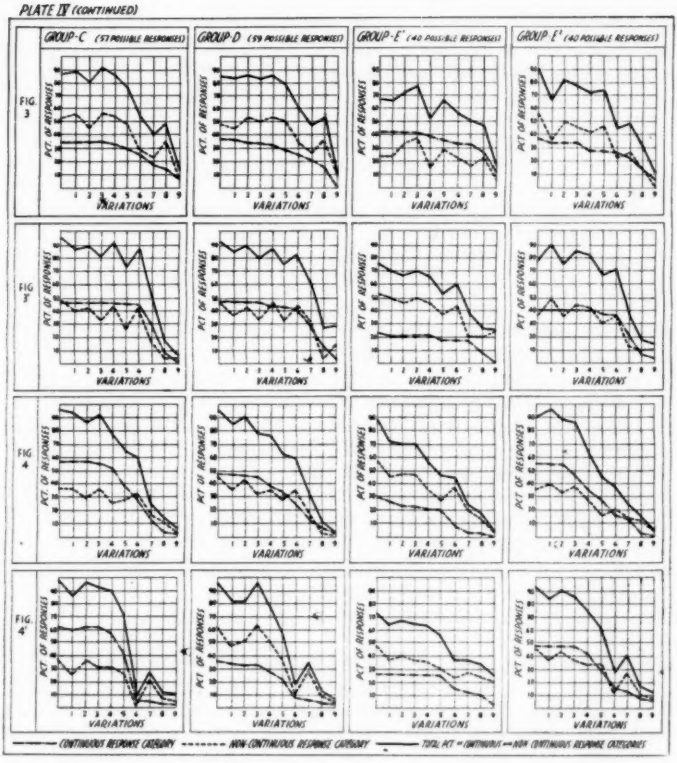
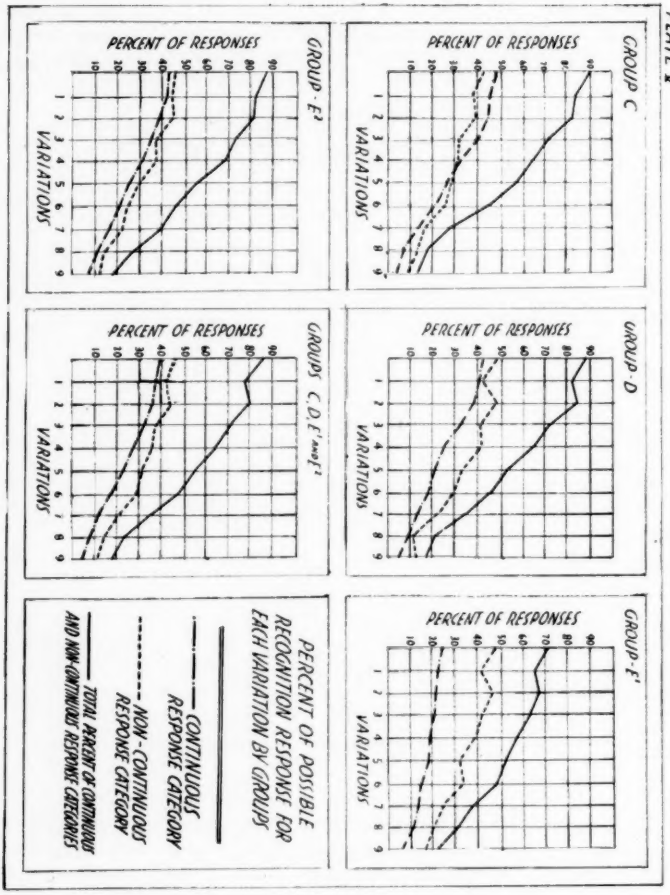


PLATE IX (CONTINUED)



was consistently above that of the continuous recognition response category. The latter was found to be less variable. These results compare favorably with those obtained by Gulliksen (21) whose work is roughly comparable to this phase of the present experiment, with the results obtained by the writer (11) in a previous and similar investigation, and with the findings of other writers whose work has been described in the Introduction. These data support the findings of other writers that new and different stimulus objects evoke the same (equivalent) responses (ostensibly) made to previously learned stimulus objects.

4. *The average reaction times of responses to figure*



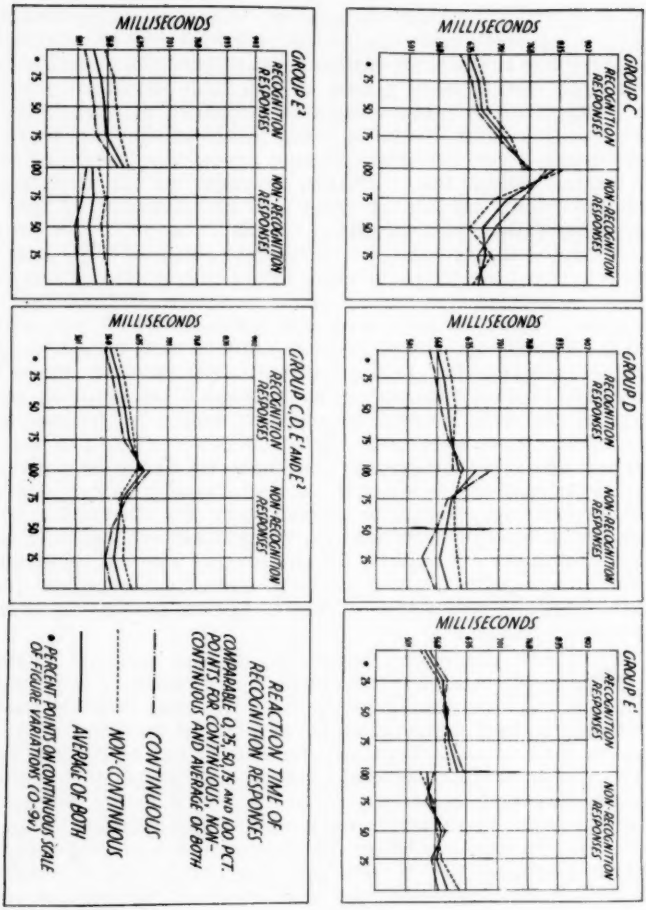
variations in terms of comparable per cent points—The reaction time data from the responses to a given figure and its nine variations were divided into Recognition and Non-recognition Response groups. Each of these groups was subdivided into continuous and non-continuous categories. Each category was further broken up into groups comparable to the last or first variation number (0-9) responded to in case

of recognition or non-recognition responses respectively, e.g., if a subject's last recognition or initial non-recognition response was to the fifth variation of a figure the given reaction time results were placed in the fifth variation group for recognition or non-recognition responses of that figure. The reaction times from as many subjects as were represented in a given variation number group were averaged by variations. From the variation averages of all variation number groups containing from 4 to 10 variations of reaction time values, comparable 0, 25, 50, 75, and 100 per cent points in the figure variation series were obtained. The average reaction time to the original figure in the case of recognition responses and to the ninth variation of that figure in non-recognition responses was taken as the 0 per cent point. The 25, 50, and 75 per cent points were obtained by simple interpolation beginning with the original figure's average reaction time value in the case of recognition responses and with that of the ninth variation in the case of non-recognition responses. The 100 per cent points were derived by extrapolation from the last two values of a given variation number group, e.g., the averaged reaction times for the last two recognition responses or the averaged reaction times for the first two non-recognition responses. The comparable per cent points for the several unequal variation number groups in a given category were then averaged for each figure, group series of eight figures or for all such groups as required.

The above procedure, suggested by the Vincent Curve technique (Kjerstad 34), was especially devised to overcome artifacts that appeared when a subject's total reaction time of response to a figure grouped in varying numbers of figure variations was averaged. By using this technique we were able to compare several reaction time series of unequal length but with relatively equal values in terms of comparable per cent points in each series. The per cent points of averaged reaction times for recognition and non-recognition responses sub-divided into continuous and non-continuous groups reflected any real trend of increase or decrease in the time of response to the nine variations of a given figure or to equivalent variations of a group of eight figures or to the variations in several groups of the same eight figures (Plate VI and Table V).

Because of their number, 128, and uninforming irregularity, the curves for the per cent points of averaged reaction times of the continuous and non-continuous recognition responses by figures are omitted here. Instead, these same

PLATE VI



results for all figures are summarized in Groups C, D, E^1 and E^2 and for all groups combined (see Plate VI and Table V). Likewise, the results for the reaction times of the Non-recognition responses are presented in groups (see Plate VI and Table V).

TABLE V

REACTION TIME (in milliseconds) OF COMPARABLE 0, 25, 50, 75 and 100 PER CENT POINTS FOR THE CONTINUOUS AND NON-CONTINUOUS CATEGORIES OF RECOGNITION AND NON-RECOGNITION RESPONSES.

	Recognition Responses			Non-recognition Responses		
			GROUP C			
Per cent Points	Cont. Cat.	Non-Cont. Cat.	Av.	Cont. Cat.	Non-Cont. Cat.	Av.
0	627	642	635	664	642	653
25	645	652	649	665	673	669
50	652	662	657	675	635	655
75	698	712	705	747	678	712
100	764	760	762	803	838	820
			GROUP D			
0	548	587	567	563	618	590
25	555	597	575	532	608	570
50	570	604	587	565	607	587
75	587	588	588	602	605	604
100	612	595	604	690	607	648
			GROUP E^1			
0	547	533	540	569	618	594
25	587	572	580	565	575	570
50	582	583	583	578	575	577
75	595	594	595	560	562	561
100	622	602	612	565	543	554
			GROUP E^2			
0	503	552	527	498	578	537
25	532	580	555	495	564	529
50	542	583	562	493	548	521
75	543	585	564	510	562	536
100	577	607	592	527	537	532
			GROUPS C, D, E^1 and E^2			
0	557	585	571	573	614	593
25	582	602	592	565	605	585
50	590	612	601	578	592	585
75	612	622	616	605	602	603
100	643	642	643	646	633	640

The essential feature of these per cent points for Groups C and D is that they reveal an increase in the reaction time accompanying the progressive variation of the figures in the case of the recognition responses and a reverse trend in the case of the non-recognition responses. These results significantly show that there were qualitative reaction time differences in the superficially equivalent responses to the figure variations.

5. *The effects of three conditions of repetition upon the percentages of response and reaction times—*

A. The following are the results of repetitions of only the Test situations immediately after initial exposure to the same situations. The data represent results from 30 subjects, 14 from Group C and 16 from Group D, and comprise what is called Sub-group E^0. Because the quantity of data in Sub-group E^0 did not justify the definitive treatment given Sub-groups E^1 and E^2 only the number and simple average of reaction time of recognition responses for the two Test situations (those in C or D and E^0) and the average number of responses per subject were obtained (Table VI).

TABLE VI

	Initial Presentation			Repetition (Group E^0)		
Groups	No. Rs.	Av. R. T.	Av. R. per S.	No. Rs.	Av. R. T.	Av. R. per S.
C	607	660	43.4	618	627	44.2
D	760	545	47.6	822	530	55.1
C plus D	1367	596	45.6	1500	570	50.0

From these results immediate repetition would seem to have the effect of decreasing the average reaction time and increasing the average number of recognition responses per subject.

B. The data for Sub-group E^1 represents the repetition of only the Test situation from 1 to 10 weeks after the initial presentation of the same situation. There were 40 subjects in this group of which 12 had previously participated in Group C and 28 in Group D. Derived from these data were the effects of repetition after longer intervals of time upon: 1. The per cent of response to the nine figure variations (see Plates IV and V) and on the 0, 25, 50, 75, and 100 per cent points of averaged reaction time (Plate VI and Table V) for recognition responses. 2. The 0, 25, 50, 75, and 100 per cent points of averaged reaction time for the non-recognition responses (Plate VI and Table V).

Inspection of the Sub-group E^1 curves representing the per cent for each variation shows a significant decrease in the

total per cent of responses under similar per cents for Groups C and D. That the continuous and non-continuous recognition response curves show this decrease is attributable solely to a decrease in the responses of subjects in the continuous category.

Coincident with this per cent of recognition response decrease, inspection of the 50 per cent points of the averaged reaction time for recognition responses in Group E^1 reveals slightly less reaction time than for comparable points in Group D and still less reaction time than for Group C. The 0, 25, 50, 75 and 100 per cent curves for Group E^1 appear to have about the same reaction time range as Group D but less than for Group C. This may be attributable to the influence of Group C subjects participating in Group E^1, e.g., it will be remembered that Group C subjects participating in the previously mentioned immediate repetition group were consistently higher than those from Group D.

Inspection of the comparable 50 per cent points of the non-recognition response reaction times in Groups E^1, C and D show a similar decrease in reaction time for E^1 under Group D with still more under Group C. The several reaction time per cent point curves for Group E^1 are unique when compared to similar curves for Groups C and D in that as non-recognition responses are made to progressively varied figures the reaction time goes up instead of down. The decrease of reaction time in E^1 under C and D is accordingly accentuated.

C. The Group E^2 data represent immediate repetition of the Test series following presentation of the Learning series, which, in turn, followed the Test series of Group E^1. The subjects were the same for Sub-groups E^1 and E^2. The Group E^2 data afford analysis of the effect of these conditions of repetition upon:

1. The per cents of response to the nine figure variations and on the 0, 25, 50, 75 and 100 per cent reaction time points of the recognition responses by individual and combined groups; and,

2. The 0, 25, 50, 75 and 100 per cent reaction time points of the non-recognition responses by groups and all groups combined.

Inspection of the curves representing the per cent of possible recognition responses to each variation shows a decided increase over percentages of response found in Group E^1, and, response per cents comparable to those of Groups C and D. Comparing the continuous and non-continuous recog-

nition response curves of Groups E^1 and E^2 this increase for E^2 is accounted for by an increase in the responses of subjects in the continuous recognition response category.

Accompanying this increase in the percentages of recognition responses are found a further decrease in the reaction times under those of Group E^1 as represented on the comparable 0, 25, 50, 75 and 100 per cent point curves for the individual and combined groups.

The non-recognition response data represented by the comparable 0, 25, 50, 75 and 100 per cent point curves show a further decrease under the similar results of Group E^1. The reaction time curves of Group E^2 show an initial but subsequently slight trend of decrease in reaction time of responses to the progressively varying figures, under those for the recognition responses. Comparison of the Group E^1 and E^2 per cent point curves shows that the curves for Group E^2 are decidedly under those of Group E^1 and all other groups.

The above results of the three conditions of repetition indicate that the subjects' stimulus-response mechanisms are considerably affected by repetition whether continuous, after intervals of time, or after interpolated learning activity.

SUMMARY OF RESULTS

1. A high degree of internal consistency of the individual subjects' responses was found in the Test situation for Groups C, D, E^1 and E^2 as indicated by a split-half technique of rank difference correlation (see p. 53).

2. Little or no relationship between the individual subjects' responses in the Learning and Test situations was found by application of Pearson's r technique between the following:

(a) The percentage of correct responses in the Learning situation and the number of recognition responses in the Test situation (see Table I).

(b) The number of pre-learning responses in the Learning situation and the number of recognition responses in the Test situation (Table II).

(c) The number of over-learning responses in the Learning situation and the number of recognition responses in the Test situation (Table III).

(d) The average reaction time of response for each subject in the Learning situation and the number of recognition responses in the Test situation (Table IV).

3. The percentage of continuous and non-continuous recognition responses to each gradient variation of a figure, for each figure in each group (Plate IV), for all figures in each group and for all figures in all groups combined (Plate V) revealed considerable internal consistency and demonstrated that the subjects responded to new and different figures as though they were constant figures. These results were found to compare favorably with those obtained by other workers.

4. The average reaction time of responses to figure variations in Groups C and D show that the greater the figure variation the longer the time of response for recognition responses and vice versa for non-recognition responses (Plate VI and Table V).

5. The percentages of response and the reaction time of response for each gradient variation of a figure were found to be affected by our three conditions of repetition (Subgroups E^0, E^1, and E^2) as follows:

(a) Immediate repetition increased the average number of recognition responses and decreased the average reaction time of response per subject (Subgroup E^0, Table VI).

(b) Repetition after longer intervals decreased the percentages of continuous recognition responses but did not appear to affect the percentages of non-continuous recognition responses (Sub-group E^1, Plates IV and V) and slightly decreased the average reaction time of responses (Plate VI and Table V).

(c) Repetition after relearning which followed repetition in (b) increased the percentages of recognition responses, particularly the continuous recognition responses (Sub-group E^2, Plates IV and V), and further decreased the reaction time of responses (Plate VI and Table V).

These results indicate that repetition has the effect of increasing the number of variations responded to and of decreasing the time of response.

CHAPTER IV—DISCUSSION

In attempting to arrive at a more adequate notion of psychological stimulus-response it is perhaps desirable that we consider our results in terms of the several current stimulus-response viewpoints previously reviewed in the Introduction and summarized here in Chart No. 2. In this way we may be better able to arrive at a more understandable basis for comparing the relative values of different interpretations of the stimulus-response phenomena. If this comparative procedure serves no other purpose it will at least throw into relief the differences between the various descriptive techniques currently employed and demonstrate the lack of unanimity among writers as to just what is meant by psychological stimulus and response. The viewpoints considered here are as follows:

A. The Psychophysical
B. The Behavioristic
C. The Dynamic
D. The Gestalt
E. The Organismic or Interactional

A. In terms of the psychophysical interpretation our experiment may be thought of as a variation of the conventional method of psychophysics and the "discrimination time" method. In these methods the subject is asked to make difference judgments between two stimuli of objectively unequal value. In the case of the method of right and wrong cases this procedure is repeated a number of times and the equal and unequal reports recorded and the means calculated to obtain upper and lower difference limens. These difference limens represent what is called the "magnitude" of sensation, sense-distance or the inverse measure of what Bentley (2) has until recently called the "psychosomatic function." The procedure in the "discrimination time" method is essentially the same save that the time of discrimination is determined as the difference between two stimuli is increased and vice versa. In this latter method differences that are judged rightly and in equal time are called subjectively equal.

In contrast to the psychophysical methods each of our subjects made difference judgments between eight constant figures and nine gradient variations of each of these figures

Stimulus-response Conceptions	Stimulus	Response	Operational Mechanism	Antecedent Factor
Psychophysical	*Physiological* light and air waves, pressure etc. (physical properties)	Psychic (sensation)	Specific psychoneural connections	Preëxistent mind-body relationship
Behavioristic	Crude objects or situations	Muscular or glandular actions	Specific neuro-muscular-glandular connections	Physiological organism
Dynamic	*Physiological* light & air waves etc. as occasions for release of body energies (drives)	Released drive or body energies	Specific and general psychoneural connections	Sets, drives, goals, purposes etc.
Gestalt	Physical Gestalten with phenomenological properties	Complete body action	Dynamic psychoneural pattern coordinations	Dynamic psychophysical systems
Organismic or Interactional	Stimulational or organismic functions	Adjustmental function of organism-as-a-whole	Unitary interactional event	Reactional biography

presented one at a time, in a chance order and with only a single presentation of each figure and its variations to each subject. The single judgments of each figure and its variations made by each of the several subjects were averaged in terms of recognition and non-recognition responses. The percentage of the total possible number of responses to each variation was obtained. Interpreting our results in terms of psychophysics we might regard some arbitrary point on our curves of per cent of response plotted against variations (Plates IV and V) of a given figure as the threshold of difference sensation between the constant figure and its subjectively different variation. With mathematical analysis based on the theory of probability we might go even further and compute, from the selected per cent of recognition judgments with given difference values, the figure variation which should give any desired per cent of recognition responses. In this manner a series of stimulus-response averages comparable to psychophysical measurements might be obtained.

In a similar comparison of the "discrimination time" method with our procedure the time of our subject's responses to each figure presented singly was measured instead of the time of discrimination between two stimuli presented in pairs. Moreover, our reaction time averages represent the means of single responses for each of a group of subjects to each of the several figure variations instead of the averages of numerous responses of single subjects. Additionally, the reaction time of recognition and non-recognition responses were obtained here while the "discrimination time" method was concerned only with the discrimination time of "right" judgments or those near the "threshold." Our recognition and non-recognition reaction time curves (Plate VI and Table V) show that as the objective difference between a figure and its variations increases the reaction time of recognition responses increases while that of the non-recognition responses decreases. The reaction time results for the recognition and non-recognition responses suggest a factor of some theoretical importance overlooked in the work of previous investigators using the "discrimination time" method. Except for these differences our procedure and results are roughly comparable to those of the "discrimination time" method.

In spite of a rough similarity of our procedure and results with those of psychophysics we fail to find that our results can be satisfactorily explained from that viewpoint. Resting on the assumption that "the bodily processes which stand in

a direct functional relation to our experiential facts takes place in the brain,—probably in the cerebral cortex" stimulus-response phenomena are regarded as expressions of a dualistic relationship or a "parallelism of psychical and cerebral processes," "the two concomitant phenomena so related that a change upon the one side manifests itself in a corresponding change on the other side" (Külpe 37, p. 4). Likewise Titchener (64, pps. 34-41) holds that psychologists must answer the question " 'why' by explaining mental processes in terms of their parallel processes in the nervous system." This position often asserted to be "scientifically indifferent to the metaphysical formulation of the mind-body relationship" (Külpe 37) appears to base its claims of objectivity on an acceptance of the nervous system as the temporally embodied twin of the mind. For example, consider Thorndike's and McDougall's neural learning theories, and more recently Bills' (3) discussion of the Sensory Process in which he concludes that "some differences in sensations are obviously due to structural distinctions in the sense organs. Perhaps others are attributable to the afferent nerve, and certainly all must ultimately depend on specificity in the brain process." Troland (65, preface) and Boring (5, 7) leave one in no doubt but that the traditional mind-body relationship is still seriously considered in modern psychology. Attention is also called to the recent work of Leeper and Leeper (43) previously described in which a correspondence between stimulus object configurations and neural configurations was sought. Of possible incidental importance are the claims of Brown and Thompson (9) who characteristically regard measurements of reaction time, memory, fatigue, illusions, etc. as indirect but generally useful measures which are not merely physical measurements but measures of correlated psychical processes. For example, Henmon (22, 23) in regarding objectively unequal stimuli responded to with equal reaction time as subjectively equal, attempted to substitute time for size in the traditional psychophysical relationship. The psychophysical concept of stimulus and response since the criticism of Delboeuf (16) and Müller (51) appears to have remained essentially the same despite later refinements and modifications to the direct and indirect methods of approaching the relationship by other writers as Cattell (4, pps. 519-528), Urban (4, pps. 529-639), Pearson (54), Dodge (17), Jastrow (26), Spearman (61), Washburn (68) and others. While there may be some justification for saying many present day psychologists no longer accept the theoretical implications of a

psychophysical relationship but rather prefer to inherit only its methodology as pragmatic tools, there is equal justification for asserting that in so far as they have any theoretical interest in the stimulus-response problem they approach it from a psychophysical conception of that phenomenon.

Aside from the untenableness of the dualistic assumption implicit in the current psychophysical viewpoints other difficulties prevent describing our results in terms of their stimulus-response formula. (1). Obviously our stimulus-response coordinations were contrived in the laboratory after learning situations and were not sought as preëxistent relationships as is assumed in the dualistic hypothesis. (2) Psychophysical methodology based as it is upon an implicit dualism furnishes an academic explanation too far removed from actual behavior situations to contribute much to a workable stimulus-response hypothesis in psychology. (3). Like those of Henmon (22, 23) and Kellogg (32) our recognition reaction time results show that the greater the difference between two stimuli the longer the reaction time. These findings appear to be of some theoretical moment as showing the mathematical artificiality of the "threshold." (4). Our additional reaction times for non-recognition responses which go beyond the work of Henmon and Kellogg appear to support a more generic and behavioral notion of stimulus-response than the psychophysical viewpoint will allow. These results at least suggest even more strongly than those for recognition responses the artificiality of the 'threshold" concept. (5). Our conditions of repetition had the general effect of increasing the number of recognition responses, decreasing the number of non-recognition responses, and of decreasing the reaction times of both recognition and non-recognition responses, which are not in harmony with either the hypothesis or methodology of psychophysics. For instance, in psychophysics it is held that the "mean value of these fluctuations (numerous judgments of given pairs of stimuli by one subject) furnish a measure of the delicacy of psychic-'sensitivity' or sense discrimination." Rather our results suggest a more dynamic interpretation of stimulus-response than the Constancy Hypothesis implicit in the usual psychophysical explanation would allow.

B. Behaviorism, it will be remembered, avoided the terms *sensation* and *perception* by substituting as the scientific datum the objective evidence of sensation and perception, namely, the discriminatory response. In this way it changed the introspective observation of psychophysics *ex post facto*

into a behavioristic one after its completion. In a like manner the conditioned reflex of Pavlov (53) and Bekhterev (1) was borrowed as a substitute for *association*. Hence, the two principal experimental methods of behavioristic psychology have been the "discrimination response" and conditioned reflex methods, both of which rest on the basic assumption that the stimulus-response phenomenon is a matter of neurological mechanisms set in operation by "anything producing a response."

In terms of the conditioned reflex method we might regard the "buzz" in our Learning Situation as the "natural" or unconditioned stimulus which elicited a lever-moving response with the aid of instructions, and the four pairs of mirror figures (Plate I) presented one at a time .58 seconds before the "buzz" as the substitute or unconditioned stimuli. During the Learning Situation the subject's lever-moving responses became gradually conditioned to these latter stimuli. Every time the subject made a "correct" response he automatically eliminated the natural stimulus, e.g., the "buzz," so that at the end of the Learning Situation, or by the time the subject was conditioned, he was responding to few or no natural stimuli. In the Control Situation other figures (Plate II) were introduced along with the Learning or conditioned figures so as to set up controlled inhibitory responses (key-pressing responses) preparatory to the Test Situation that followed. In this latter situation the eight conditioned stimuli and nine gradient variations of each were presented singly and in a chance order. The conditioned responses to the figure variations might be regarded as providing a measure of the subject's neuro-physiological differentiation or selection among the various stimulus variables, or, of the converse "inhibitory" effects of the figure variations responded to by key-pressing responses (non-recognition responses).

Our per cent of recognition responses to the several figure variations (Plates IV and V) which show a progressive decrease in the number of subjects responding to the correspondingly gradient variations may be considered as being in accord with Pavlov's "initial generalization of cortical irradiation" previously described in the Introduction (Pavlov 53 and Loucks 46). The decided increase in recognition responses upon immediate repetition (Group E^0, Table VI) is difficult to explain since it is generally held that the conditioning process grows weaker (more extinct) upon repetition without "reinforcement." The results of repetition after longer intervals of time (Group E^1, Plate V) show a marked decrease in the per cent of recognition responses which may

be thought of as illustrating "extinction." However, as has been noted before this decrease is accounted for solely as a decrease in the number of continuous recognition responses so that the "extinction" explanation would hold only for the continuous recognition responses leaving the non-continuous recognition responses unaccounted for. The marked increase in per cent of continuous recognition responses in Group E^2 (Plate V), the result of repetition following the repetition in Group E^1, might be due to "reinforcement" during the immediately preceding Learning Situation, but here again we find this increase attributable entirely to an increase in the per cent of continuous recognition responses and not to the non-continuous recognition responses. It might be argued that only the continuous recognition responses can be regarded as conditioned responses and that the non-continuous recognition responses were not conditioned enough for consideration here, but this would be to question the general applicability of the conditioned reflex concept to stimulus-response phenomena.

While the reaction time technique does not appear to have been often used with the conditioned reflex method it is attempted here to describe our general reaction time results from the Behavioristic Viewpoint. As the figure variations increased they were found to be accompanied by a roughly corresponding increase in reaction time for recognition responses and vice versa for non-recognition responses (Plate VI and Table V). These results can be logically explained in terms of the rate of neural conduction in the corresponding neural mechanism supposedly involved in the "initial generalization of cortical irradiation" and "neurological inhibition" hypotheses. It can readily be seen that to attempt further explanation in these terms of our various time results for Groups C and D, E^0, E^1, and E^2 (Plate VI and Tables V & VI) could only be done with violence either to these hypotheses or to our results. Suffice it to say that the present knowledge of neurophysiology is already strained to accommodate "initial generalization" and "inhibition" and that to go further would be sheer speculation.

Description of our results in terms of the stimulus-response formula of behaviorism reveals objections not only to the Behavioristic concept but to the adequacy of its methodology. (1). Most laboratory-determined conditioned reflexes are reported to be extremely sensitive, difficult to obtain, readily inhibited by extraneous stimuli, and to become extinct without frequent reinforcement with the natural stimulus. If this be true it is extremely doubtful that the

phenomena dealt with here were conditioned reflexes at all, in which case, the Behavioristic Stimulus-response formula would appear applicable to only limited physiological phenomena and be entirely unsuited to a general description of human behavior. (2). By emphasizing elementarism of nervous elements embodied in the Behavioristic concept the complete and unitary functioning of the whole organism is minimized, the historically continuative processes are unaccounted for, a fallacious "start-from-rest" neurological hypothesis is assumed and in general the concept runs counter to a more dynamic concept our results seem to imply. (3). Certain results from our conditions of repetition appear to be contradictory to the reported conditioned reflex phenomena of extinction and reinforcement as previously noted. (4). Even logical description of our reaction time results in terms of "initial generalization" and "inhibition" are not justified in light of Louck's (46) recent findings described here previously. Discounting Louck's work one might still reasonably object that too little is known of neurophysiology to regard these hypotheses as more than interesting speculation. (5). Moreover, the work of Coghill (15), Herrick (24), Lashley (40, 41, 42), Sherrington (58), Skinner (59, 60) and others show conclusively that there is no such stimulus-response unit as assumed here except possibly for a few of the most elementary reflexes. The principles of cerebral equipotentiality, mass action and other similar indications that the nervous system and the organism function as a unit are all contrary to the physiological assumptions of the Behaviorists.

C. Description of our results from the viewpoint of Dynamic Psychology is necessarily haltered by the occasional role allotted to the stimulus and by the priority of function given the causal drive energies of the inner processes released by the stimulus and producing the response. In fact, the role given the stimulus by Thurstone (62, 63) is so incidental that we are compelled to consider here only Woodworth's (71, 72) interpretation of stimulus-response.

According to this latter interpretation light waves from our geometric figures constituted the stimuli and finger and wrist movements supported by the body-as-a-whole, the responses. The response is thought of as a release of inner bodily energies called drives or neuromuscular motor sets. The stimulus serves as an energy releaser so that the origin of the drive or motor set becomes the principal interest, the basic assumption being that the entire series of our subject's acts is guided and controlled with reference to a per-

sistent set which fulfills the role of a goal idea. Accordingly, after a preliminary period of adaptation (i.e., the instructions and trial period) which served to make learning more rapid, the subjects learned to make the prescribed responses through repetition, reward and punishment. This procedure may be thought of as a "process of developing structure through activity" (72, p. 224). Learning completed, wholly different figures (Plate II) were introduced among those learned (Plate I) and the subjects developed a different motor set for the new figures which required a key-pressing or non-recognition response. Variations of the learned figures (Plate III) were then presented and it was found that the subjects retained their set for or transferred responses to some of the figure variations. This transfer of response among recognition responses accompanying the gradient increases in figure variations (Plate VI and Plate V) might be attributed to the functional limits of the cerebro-neural structure modifications (72, p. 221) acquired during learning and hence to the persistence of the resultant motor sets operative in the Test situation. The reaction time increase for recognition responses to figure variations might similarly be explained in terms of some such neurophysiological notions as Pavlov's Initial generalization of cortical irradiation or Wertheimer's Cortical short circuits. In a like manner one might explain the transfer of non-recognition responses and the decrease in reaction time of these responses to figure variations. The response and reaction time results of recognition and non-recognition responses for our conditions of repetition may likewise be attributable to subsequent modifications of the cerebro-neural structures and resultant set activities during the several experimental situations. However, due to the paucity of pertinent scientific data concerning sets we are unable to offer any specific suggestions as to just how these results might be explained in these terms.

If the above recapitulation of our results in terms of the stimulus-response formula of Dynamic Psychology seems forced and to do violence to the Dynamic stimulus-response concept we submit in extenuation that the Dynamic formula is usually applied to work on the comparative strengths of animal drives such as sex, hunger, thirst, etc. and that more comparable descriptions of the more complex stimulus-response phenomena in human subjects are not available in the literature (Woodworth 71, 72 and Young 73). Aside from this handicap, inspection of the stimulus-response concept of Dynamic Psychology as it applies to our results suggests

other objections. (1). In light of the emphasis and causal priority placed upon drives or sets the stimulus variable is reduced to the incidental role of a mere energy releaser. Our results for responses to figure variations, reaction time of recognition responses and conditions of repetition indicate a more important role is played by the stimulus variable than the Dynamic formula provides for. Likewise, our results do not appear to justify either the assumption of, or emphasis placed on, such sets or drives as are found in this conception. Rather, they suggest a more behavioral unity in stimulus-response events with the abstracted stimulus variable playing a more proportional role of importance. (2). Implicit in the stimulus-response formula of Dynamic Psychology are first, an elementarian and mechanistic assumption of drives and sets correlated with physiological structures, i.e., hunger, sex, thirst, etc., and secondly, drives of another type such as life plan, ambition, curiosity, interest, etc. all with a teleological and metaphysical implication. These two types of drives are not usually distinguished; rather, the first is the more often presented and the second vaguely associated with neurophysiology. As McDougall (48) has pointed out the teleological and mechanistic conceptions are mutually exclusive of each other and cannot logically be fused by using the overloaded nervous system as a *deus ex machina.* It would appear that the mixture of the two at least in part accounts for the confusion when the Dynamic formula is applied to our results. (3). As has been asked before in the Introduction, is it reasonable to assume that there are enough varied physiological conditions to be generally thought of as drives for the enormously complex number of activities the psychological organism performs? Moreover, can we have an operative stimulus-response formula if drives are assumed to occupy a prior and causal role? This question raises serious doubt as to the adequacy of the Dynamic stimulus-response concept for experimental psychology. Finally (4), the Dynamic stimulus-response conception is avowedly concerned with the description of causal chains of events that differs from the usual psychophysiological view only in that the causal priority of drives is assumed. In consequence, the formula affords a less approximate description of psychological stimulus-response than the psychophysiological views previously discussed in that the stimulus-response variables are practically disregarded so great is the emphasis placed on drives. Certainly, there are many difficulties here that prevent a rigorous description of stimulus-response phenomena. For instance, both the

terminal and lateral limits of the causal chain are indeterminate as illustrated in the above attempts to describe our results from this and the two previous viewpoints, and, by the work of Skinner (60) and the writer (11) previously described. Moreover, the results here suggest that the stimulus-response phenomena were systemic events whose interrelations resist description as simple series of causes and effects.

D. In attempting description of our experiment from the viewpoint of Gestalt Psychology it is necessary that the Gestalt tenet of psychoneural isomorphism be understood. Isomorphism is a notion that the spatial order of perceptual experience corresponds to the spatial order of the underlying neural processes. Boring (7) has recently given an excellent analysis of the dualistic problems involved in this Gestalt principle.

During our Learning Situation there occurred an "intentional organization" between the individual geometric or Gestalt figures (Plate I) and the prescribed right and left response-lever movements of the subjects with the help of instructions, the "buzz" and other "time and space" influences. These Gestalt figures having been coordinated with response-lever movements, new and wholly different geometric figures (Plate II) were introduced among them in our Control Situation and more general coordinations organized between these new and different figures and key-pressing responses. Then, in the Test Situation that followed the Gestalt figures of only the Learning Situation and nine variations of each were presented one at a time and in chance order (Plate III), and the subjects instructed to respond with appropriate response-lever movements to figures recognized as having been in the Learning Situation and with key-pressing responses to all other figures not recognized as such. During all three experimental situations the subjects' differential responses and their reaction times were recorded.

The percentages of recognition responses to figure variations (Plates IV and V) in Gestalt terms might be regarded as "transposition phenomena" and roughly comparable to the work of Lashley (38, 39, 40) and Köhler (36, pps. 216-217) described in the Introduction. These phenomena might be explained from the Gestalt viewpoint in two ways. *First,* the figure variations up to the point of breakdown in "organization" were not sufficiently varied to disturb the essential phenomenological properties of the figure and hence the phenomenologically perceived Gestalt and its underlying dynamic distribution of spatial equilibrium. *Second,* the

phenomena might be considered as special cases where explanations are phenomenal but associated with physical laws such as a combination of Wertheimer's assumption of "cortical short-circuits" underlying phiphenomena, Köhler's mnemonic "traces" (36, pps. 278, 290-292, 301-315) considered as neural entities following physical laws of growth, decay and assimilation and the Gestalt principles of spatial organization in the brain. From these assumptions it might be reasoned that the neural pattern for a figure variation drains, or drains into, the previously organized figure's spatial mnemonic traces in cases where the difference is not too great. Supposedly, since the non-recognition responses were made to more general stimulus patterns, corresponding spatial organization, mnemonic traces and short-circuits operated over a larger and more general neural area. In a like manner our reaction time results for recognition and non-recognition responses (Plate VI and Table V) might be similarly interpreted. For instance, the decrease accompanying increases in figure variations might be thought of as due to the time required in the drainage process of correspondingly more distant spatial projections in the brain from or to the locations of mnemonic residue patterns of previously organized figure projections. The results of repetition may likewise be interpreted in terms of mnemonic traces (36, Köhler, pps. 290-292) and the other neural factors employed with the per cent of response and reaction time results. The increase in the number of recognition responses and the accompanying decrease of reaction times (Table VI) might be explained as "growth" properties of traces. For instance, the neural residues from the first presentation of figures and variations responded to left larger and better "organized" spatial patterns which operated to extend the range of figure variations later responded to and facilitated more immediate and speedier responses. According to this explanation the relatively unchanged number of non-continuous recognition responses and the decreased reaction times obtained following repetition after longer intervals of time (Group E^1 Plates IV, V, VI and Table V) would be attributable to the neural residues left by previous presentations in the Learning Situation and operating as described in the preceding incidence of repetition above. The marked decrease in the number of continuous recognition responses might be considered evidence of residual decay though it is not clear why this decay did not similarly affect the non-continuous recognition response results. Again, the further response increase and reaction

time decrease during the repetition (of Group E^2) which followed that of Group E^1 immediately after an intervening Learning Situation, presumedly resulted from the reinforced organization effects of the immediately preceding Learning Situation on the neural traces, although it is not clear just how this operated to the exclusive benefit of the continuous recognition responses whose increased number entirely account for the total response increase.

From the above explanations it must be clear that, aside from the phenomenological, unknowable, or transpatial aspects of the stimuli and response patterns, the Gestalt view of stimulus-response events largely hinges on the coordination of existential physical properties of the stimulus with afferent and cortical nerve structures which underly its principle of psychoneural isomorphism. The scientific objections to this view of stimulus-response are similar to those previously made to psychophysics. (1). Except for some of Lashley's work (42) which can be interpreted as support for the Gestalt notion of brain patterns, the Gestalt neural hypotheses such as trace entities and cortical short-circuits are not founded on any neurological evidence but entirely on phenomenological data.*

With this evidence it is highly questionable whether the Gestaltists' implications of an intensive isomorphism is any more interesting as speculation than Pavlov's cortical irradiation and inhibition. Accordingly, the foregoing interpretations of our data in these terms are hardly acceptable in any serious scientific sense. Indeed, it is a pertinent question to ask if it is possible for a dualistic position to offer an objective conception of stimulus-response events? (2). The universality of Gestalt Psychology's principles of phenomenology weakens the adequacy of its stimulus-response conception's applicability as reference to the first alternative Gestalt explanation of our results will show. (3). Except for the assumption of neural trace entities no account is given of the historically continuative processes operative in our experiment and evidenced in our results for all three experimental situations. (4). As Boring (7) has shown the Gestaltists' objection to the "constancy hypothesis," the assumption that perception and its stimulus have a constant relationship, is precisely the proper objection Gestalt psychologists should have to psychoneural isomorphism. The demonstrated influence of learning and later repetition on

* Zangwill (75) has recently published an interesting study in which he fails to find any phenomenological evidence to support Koffka's trace entities.

the functional value of the stimuli operative in our experiment make a stimulus-response concept based on any kind of "constancy hypothesis" inadequate. Rather, a more behavioral stimulus-response conception seems indicated by our results.

E. The Organismic or Interactional viewpoint (Kantor 27 vol. I, 28, 29, 30, 31) regards psychological stimulus-response as a behavioral event and unlike the preceding viewpoints eschews emphasizing the nervous system as an explanatory mechanism. It finds support in Skinner's (60) recent suggestion that psychology would do well to give up the nervous system and center its attention on the end-terms of events where observation is more direct and there is less temptation for insecure speculation. Accepting stimulus-response events as its data the response is thought of as complete body action in a time-space frame of reference and the psychological stimulus as the corresponding action or function performed by the stimulus in a given interactional situation. Both the stimulus and response variables are regarded as abstracted phases of interactional happenings rather than discrete physical or physiological entities. Emphasized are the spontaneous and historical interactional character of the stimulus-response event.

From this viewpoint our experiment would be described in terms based on analysis of behavioral events. For instance, the Learning Situation would be regarded as a process for contriving prescribed interactional coordinations between right and left response-lever movements of the reacting individual and corresponding stimulus-functions or values in the several geometric figures (Plate I) previously uncoordinated in the prescribed sense. The coordinations having been established a different type of coordination was introduced between new and different geometric figures and a different or key-pressing reaction either by means of instructions alone as in Group C or by both instructions and actual different figures (Plate II) as in the Control Situation of Group D. Following this, in the Test Situation only the figures presented in the Learning Situation and nine variations of each were presented singly and in chance order. This procedure would be regarded as a test of the operational limits of the eight coordinations contrived in the Learning Situation in terms of the effects of figure variations on the reaction time of responses and the degree of variation necessary before the stimulus-functions for given figures broke down.

Our results interpreted from this viewpoint would be ex-

pected to show some kind of relationship between the Learning Situation in which coordinations were contrived and the subsequent operation of the stimulus and response variables in the Test Situation. Little or no evidence of such relationships was revealed in our Pearson's r's between the various features in the two experimental situations such as: (1) the low r's between percentages of correct responses in the Learning Situation and the number of recognition responses in the Test Situation (Table I); and the zero r's between the number of recognition responses in the Test Situation and (2) the number of pre-learning responses (Table II); (3) the number of over-learning responses (Table III); and (4) the average reaction times of response for each subject in the Learning Situation (Table IV). However, in spite of no significant correlations between these features all psychologists would probably agree that there was some considerable relationship between our Learning and Test Situations. The problem is, which features in learning are related with what test features? All we can say is that the features investigated here showed a surprising lack of relationship.

From the Organismic concept of stimulus-response our per cents of recognition responses (Groups C and D, Plates IV and V) would be interpreted as mathematical representations of two types of stimulus-functions, i.e., (1) those built-up in the eight constant figures by the subjects during the Learning Situation and coordinated with right and left response-lever movements, and (2) those built-up after the Learning Situation either by instructions alone as in Group C or by both instructions and the Control Situation as in Group D and coordinated with key-pressing responses.*

The *first type* of stimulus-function would be thought of as having *loci* in terms of the range of a given figure's variations evoking the recognition responses originally coordinated with the constant figure. The range of figure variations evoking non-recognition responses coordinated with figures "different from those learned" would be considered as *loci* of the *second type* of stimulus-function. In both types it would be maintained that the actual stimulus involved was not primarily the geometric figure nor its physical properties but the stimulus-function previously acquired by the figure. Moreover, the two types of stimulus-functions are thought of as competing against each other over the gradient scale of a

* Curves for per cents of non-recognition responses would be the exact reverse of those for recognition responses since any non-recognition per cent point can be derived by simply subtracting the companion per cent point of recognition responses from 100% of possible responses.

given figure's nine variations, i.e., (1) the prior and well established stimulus-function coordinated with recognition responses that tends to prevail in the range of lesser figure variations and (2) the later and less well established stimulus-function coordinated with non-recognition responses that predominate in the remaining range of more extreme figure variations. These results, like those of Köhler's (36) transposition experiments and Klüver (35) and Leeper's (43) equivalent stimuli, appear to support the Organismic concept of stimulus-response in that here a range of figure variations may be considered as demonstrating a *locus* of stimulus-function.

Our reaction time results for both recognition and non-recognition responses appear to give considerable support to this "competitive character of stimulus-response events" (Kantor, 29; 334-335). In Groups C and D (Plate VI and Table V), the competition between the two types of stimulus-functions coordinated with recognition and non-recognition responses respectively would be considered responsible for the increasingly greater reaction times of recognition responses and the steadily decreasing reaction times of non-recognition responses accompanying increases in figure variations. For instance, as the stimulus-function coordinated with recognition responses approaches its breakdown point (last figure variation in which it inheres) and nears the *locus* of the stimulus-function coordinated with non-recognition responses the covert influence of the latter stimulus-function progressively increases the reaction time of recognition response. Likewise, the persisting counter influence of the stimulus-function coordinated with recognition responses is covertly reflected in the steadily decreasing reaction time of non-recognition responses as the latter's coordinated stimulus-function becomes more and more removed from the *locus* of the competing stimulus-function. For example, the stimulus-function coordinated with recognition responses and inhering in variation number 2 of a figure would be affected less by the competing stimulus-function than when variation number 4 was presented. On the other hand, the stimulus-function coordinated with non-recognition responses would be affected less and less by the other stimulus-function as the figure variations increased away from those within the *locus* of the competing stimulus-function (Drawing A). Moreover, that the specific stimulus-functions coordinated with recognition responses were better established than the later and less well established stimulus-function coordinated with non-recognition responses is re-

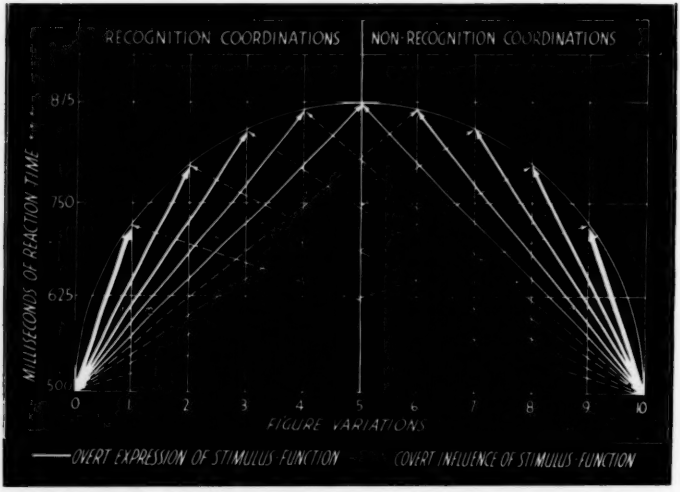


Illustration of the competitive character of two R SF coordinations reflected in their reaction times of response over a scale of gradient figure variations.

flected in the percentage point curves of reaction times which are smoother and show smaller ranges of reaction time for recognition responses than for non-recognition responses (Groups C and D, Plate VI and Table V). In a like manner, the greater reaction time range of Group C may be attributable to the introduction of the Control Situation in Group D, i.e., the Control Situation operated to establish better the stimulus-function coordinated with non-recognition responses and lessen the reaction time of non-recognition responses and because of the latter's competing influence, the reaction time of recognition responses (compare the millesecond coordinates of Groups C and D, Plate VI and Table V).

Interpreting our results for immediate repetition of the Test Situation (Table VI) which show an increase in the number of and a decrease in the average reaction time of recognition responses, it might be assumed that repetition had the effect of stabilizing and better establishing both stimulus-functions. This would imply a lessening of their competitive character and account for the decrease in the

average reaction times.* With less competition between the two stimulus-functions it may be assumed that the stimulus-function coordinated with recognition responses being prior and better established would account for the increased number of recognition responses.

Repetition results for our Test Situation after longer intervals of time (from 1 to 10 weeks) make explicit interpretation from the Organismic viewpoint somewhat difficult because of the complications of uncontrolled experiential factors in the time intervals. For example, inspection of the per cents of recognition responses for Group E^1 (Plate V) reveals a general decrease in recognition responses over those for Groups C and D. However, the decrease is entirely due to a marked loss in the continuous response category. This might suggest that the more specific stimulus-response coordinations for the recognition group deteriorated during the time intervals leaving the more general non-recognition coordinations predominant since a decrease in the per cents of recognition response curves means an equivalent increase in non-recognition responses. Concomitantly, we might hazard that the covertly competitive influence of non-recognition coordinations would affect the recognition coordinations more than the latter would the former. Inspection of the reaction time curves for Group E^1 (Plate VI and Table V) showing a progressive increase for recognition reaction time, then a drop for initial non-recognition reaction times followed by a slight increase, would seem to offer some support for this explanation.

Further repetition with these same subjects, following the intervening Learning and Control Situations, resulted in an increase in recognition responses comparable to the per cents in Groups C and D and entirely attributable to an increase in the continuous response category, as shown by the per cents of recognition response curves for Group E^2 (Plate V). It may be assumed that the preceding Test Situation of Group E^1 and the more immediately preceding Learning and Control Situations were not without effects on the stimulus-functions coordinated with recognition and non-recognition responses respectively. For instance, repetition and relearning may have better established the two stimulus-functions and reduced competition between them. The reaction time curves for Group E^2 (Plate VI and Table V) appear to support some such explanation. For example, the curves

* Cassel and Dallenbach (14) report similar effects of 'distraction' as most frequently lengthening reaction time and occasionally after brief initial disturbance leaving the time unaffected.

for both recognition and non-recognition responses show a total decrease in reaction times under those of all other groups. Furthermore, the recognition reaction time curves reveal a progressive increase and the non-recognition time curves, after an initial drop under the recognition curves, have a slight decrease tendency.

The Organismic stimulus-response conception appears to offer a purely behavioral description of our results summarized as follows: (1) the variation range of our figure variations coordinated with recognition and non-recognition responses reveal *loci* for the two types of stimulus-functions; (2) our reaction time results for recognition and non-recognition responses appear to be satisfactorily described in terms of the competitive character of stimulus-response events; (3) the Learning and Test results of our several conditions of repetition reveal historically continuative processes which are taken into account by this formula. Additionally, the concept not only relies exclusively on objective end terms of behavioral events but appears to offer a sound logical technique for handling psychological data without resorting to psychoneural or other speculative concepts of questionable scientific status. On the other hand, one might object that the formula in being so inclusive is too general and complicated but perhaps stimulus-response events are themselves refractory to simpler descriptions.

Our results interpreted from the Organismic viewpoint appear to have implications for many current psychological problems. Among these we might consider equivalent stimuli, transfer in learning and systemic implications for the field of abnormal behavior. The work of the Gestaltists generally (36), Lashley (39), Klüver (35) and the Leepers (43) on equivalent stimulation appears to be based upon the conception that stimuli are objects. Kantor (29) has suggested that this work does not upset stimulus-response psychology as Klüver has held but supports a more adequate and behavioral notion of the phenomena (behavior segments). Kantor further questions the notion of equivalent stimulation holding that the stimuli were not equivalent but identical in that the operative stimuli were not objects but stimulus-functions. Our reaction time results do not appear favorable to the notion of equivalence for if figure variations evoking the same response given to a constant figure be thought of as equivalent how would the reaction time increases accompanying increased figure variations be accounted for? Our findings that qualitatively the responses to figure variations were not equivalent would seem to se-

riously question the notion of equivalent stimulation. The phenomenological explanation of stimulus-response mechanisms Klüver suggests in the absence of correlation between physical properties of stimuli and their responses are of doubtful scientific value. Certainly Kantor's notion of a stimulus-function would appear much more acceptable than that of a group of equivalent stimuli requiring a phenomenological or unknowable explanation.

In view of the confusion prevailing generally among the theories of learning and more specifically in the transfer effects of learning the Organismic explanation of our stimulus-response data would appear to hold important implications for these problems. In point are the conflicting notions or relative and absolute elements of transfer. For example, the results of Gulliksen's (20, 21) excellent work on transfer of response might be more adequately described in terms of stimulus-functions than as transfer of responses coordinated with relative object features. In the face of failure to find an exact correlation between physical properties of stimulus objects and responses the notion of relative transfer appears to be a forced modification of the view that objects are coordinated with responses.

The systematic implications of the interactional conception of stimulus-response for such problems as abnormal behaviors appear to answer Thurstone's (63) objections that a stimulus-response psychology is so restricted and academic as to render its approach to the practical problems of human behavior almost worthless. This author has inveighed against stimulus-response psychology claiming that psychologists must adopt some such approach as psychoanalysis. A sense of proportion prevents developing here the logical technique of Organismic Psychology for handling the problems of mental pathology (Kantor, 27, Vol. II, Chap. XXX). The reader is referred to an application of these implications by the writer (Carter 12) and to the approach of the Meyer school in Psychiatry (Campbell 10) which serve roughly as a demonstration of the applicability of the viewpoint. The conventional notions of psychological stimulus-response are admittedly inadequate for study of actual human behavior such as the abnormal field but perhaps few psychologists would care to accept the medieval demonology of psychoanalysis (Wolfe 70). The Organismic viewpoint appears to offer a more objective approach not only to the more academic problems of psychology but also to provide a technique for handling the less controllable events of human behavior.

SUMMARY

The present investigation arises out of the confusion and discontent expressed by several writers over psychological stimulus and response. After critically examining the more prominent current interpretations and reviewing the experimental literature an experimental analysis of the fundamental mechanisms in human behavior was attempted for the purpose of searching for a more adequate description of psychological stimulus and response. To this end the following procedures were employed:

1. *Learning*
   (a) Four pairs of mirrored geometric figures were presented one at a time and in a chance order to 116 subjects individually and each was required to make prescribed differential responses of recognition to the figures.
   (b) The subjects then learned to make non-recognition responses to four other pairs of mirrored figures.

2. *Test* Only the first four pairs of figures and nine gradient variations of each figure were presented in a chance order.

3. *Repetition*
   (a) The procedure in 2 was immediately repeated in the case of 30 subjects.
   (b) 40 subjects repeated the procedure in 2 from one to ten weeks later.
   (c) Procedures 1 (a and b) and 2 were repeated immediately following the procedure in 3 (b).

The recognition and non-recognition differential responses and the reaction times were secured.

From this data the following results were obtained:

1. A high degree of internal consistency of the individual subject's responses was indicated in the Test Situations by the split-half technique of rank difference correlation.
2. Application of Pearson's r technique revealed little or no relationship between the features of the Learning and Test Situations investigated.
3. All subjects were found to make recognition responses to figure variations in all Test Situations as though they were the original figures learned.
4. Accompanying increases in figure variations in the first Test Situation (see procedure 2 above) were increases in

reaction time for recognition responses and decreases for non-recognition responses.
5. Immediate repetition of the Test Situation (see procedure 3a above) increased the average number of recognition responses and decreased the average reaction times.
6. Repetition of the Test Situation after longer intervals of time (see procedure 3b above) decreased the percentages and reaction times of recognition responses.
7. Test repetition after relearning (see procedure 3c above) which followed repetition in 6 increased the percentages of recognition responses and further decreased the reaction time of responses.

An attempt was made to interpret these results in terms of the descriptive techniques of the several current conceptions of psychological stimulus-response previously examined, viz., the Psychophysical, Behavioristic, Dynamic, Gestalt and Organismic or Interactional (see Chart 2). The Organismic or Interactional viewpoint appears to offer the most satisfactory descriptive stimulus-response technique for handling our results. According to this conception psychological stimulus-response is a unitary interactional event in the reactional biography of an individual. Out of such happenings the stimulus and response variables are analyzed. The stimulus is thought of as the stimulating function or value an object or situation has for the interacting individual, while the response is held to be the coordinated adjustmental function the individual makes to the stimulus-function. In contrast to the other viewpoints considered this latter appears to account adequately for the historically continuative processes, and to avoid oversimplifications and an unjustifiable emphasis on neurophysiology with attendant implications of a higher activity (mentalism). In brief, this conception would seem to offer a satisfactory and purely behavioral stimulus-response technique for the handling of our results.

BIBLIOGRAPHY

1. Bekhterev, V. M., *General principles of human reflexology*. New York: International Publishers, 1932, 467 p.
2. Bentley, M., *Fields of psychology*. New York: Appleton, 1924, Chapt. xvii.
3. Bills, A. G., *General experimental psychology*. New York: Longmans Green, 1934, 620 p.
4. Boring, E. G., *A history of experimental psychology*. New York: Century, 1929, 699 p.
5. Boring, E. G., *The physical dimensions of consciousness*. New York: Century, 1933, 251 p.
6. Boring, E. G., Special review of Koffka's Principles of Gestalt psychology. *Psychol. Bull.*, 1936, 33: 59-69.
7. Boring E. G., Psychophysiological systems and isomorphic relations. *Psychol. Rev.*, 1936, 43: 565-587.
8. Bridgman, P. W., *The logic of modern physics*. New York: Macmillan, 1927, 228 p.
9. Brown, W., & Thompson, G. H., *The essentials of mental measurement*. London: Cambridge Univ. Press, 1921, 216 p.
10. Campbell, C. M., Adolf Meyer. *Arch. Neurol. & Psychiat.*, 1937, 37: 715-731.
11. Carter, Jr., J. W., An experimental study of the stimulus-function. *Psychol. Rec.*, 1937, 1: 35-48.
12. Carter, Jr., J. W., A case of reactional dissociation (Hysterical paralysis). *Amer. J. Orthopsychiat.*, 1937, 7: 219-224.
13. Carter, Jr., J. W., A new serial presentation apparatus. *J. Gener. Psychol.*, 1937, 17: 409-414.
14. Cassell, E. E., & Dallenbach, K. M., The effect of auditory distraction upon the sensory reaction. *Amer. J. Psychol.*, 1918, 29: 129-143.
15. Coghill, G. E., *Anatomy and the problem of behavior*. Cambridge: The Univ. Press, 1929, 113 p.
16. Delboeuf, J. R. L., *Éléments de psychophysique, général et spéciale*. Paris: Germer, Bailliere et Cie, 1883.
17. Dodge, R., *Conditions and consequences of human variability*. New Haven: Yale Univ. Press, 1931, 162 p.
18. Franz, S. I., Visual cross education and cerebral function. *Psychol. Bull.*, 1931, 28: 206.

19. George, S. S., Attitude in relation to the psychophysical judgment. *Amer. J. Psychol.*, 1917, 28: 1-37.
20. Gulliksen, H., Study of transfer of response: 1. Relative versus absolute factors in the discrimination of size by the white rat. *J. Genet. Psychol.*, 1932, 40: 37-51.
21. Gulliksen, H., Transfer of response in human subjects. *J. Exper. Psychol.*, 1932, 15: 496-516.
22. Henmon, V. A. C., The time of perception as a measure of differences in sensation. *Arch. Philos., Psychol., & Sci. Methods*, 1906, no. 8.
23. Henmon, V. A. C., The relation of the time of a judgment to accuracy. *Psychol. Rev.*, 1911, 18: 195.
24. Herrick, C. J., *Behavior and mechanism. In mind and behavior.* New York: Van Nostrand, 1929, pp. 9-44.
25. Hunter, W. S., Some notes on the auditory sensitivity in the white rat. *Psychobiol.*, 1918, 1: 339-351.
26. Jastrow, J., Critique of psychophysic methods. *Amer. J. Psychol.*, 1888, 1: 271-309.
27. Kantor, J. R., *Principles of psychology.* New York: Knopf, 2 vols. 1924.
28. Kantor, J. R., *A survey of the science of psychology.* Bloomington, Ind.: Principia Press, 1933, 564 p.
29. Kantor, J. R., In defense of stimulus-response psychology. *Psychol. Rev.*, 1933, 40: 324-336.
30. Kantor, J. R., Concerning physical analogies in psychology. *Amer. J. Psychol.*, 1936, 48: 153-164.
31. Kantor, J. R., The nature of psychology as a natural science. *Acta Psychol.* (in press).
32. Kellogg, W. N., The time of judgment in psychometric measures. *Amer. J. Psychol.*, 1931, 43: 65-86.
33. Kinnaman, A. J., Mental life of two Macacus rhesus monkeys in captivity. *Amer. J. Psychol.*, 1902, 13: 98-149.
34. Kjerstad, C. L., The form of the learning curves for memory. *Psychol. Monog.*, 1919, 26: 89.
35. Klüver, H., The equivalence of stimuli in the behavior of monkeys. *J. Genet. Psychol.*, 1931, 39: 3-27.
36. Köhler, W., *Gestalt psychology.* New York: Liveright, 1929.
37. Külpe, O., *Outlines of psychology.* London; Swan Sonnenschein, 1909, 3rd. ed. (trans. by W. B. Titchener).
38. Lashley, K. S., Studies of cerebral function in learning. VI. The theory that synaptic resistance is reduced by the passage of the nerve impulse. *Psychol. Bull.*, 1924, 31: 369-375.

39. Lashley, K. S., Learning: 1. Nervous mechanisms in learning. Chapt. 14. in *The foundations of experimental psychology*, ed. by C. Murchison. Worcester, Mass.: Clark Univ. Press, 1929, pp. 524-563.
40. Lashley, K. S., Basic neural mechanisms in human behavior. *Psychol. Rev.*, 1930, 37: 1-24.
41. Lashley, K. S., Cerebral control versus reflexology: a reply to Professor Hunter. *J. Gener. Psychol.*, 1931, 5: 3-20.
42. Lashley, K. S., & Wiley, L. E., Mass action in relation to the number of elements in the problem to be learned. *J. Comp. Neurol.*, 1933, 57: 1-55.
43. Leeper R., & Leeper, D. O., An experimental study of equivalent stimulation in human learning. *J. Gener. Psychol.*, 1932, 6: 344-376.
44. Lewin, K., *A dynamic theory of personality*. New York: McGraw-Hill, 1935, 286 p.
45. Lewin, K., *Principles of topological psychology*. New York: McGraw-Hill, 1936, 231 p.
46. Loucks, R. B., Pavlov's theory of cortical irradiation in light of some recent experiments with conditioned reflex. *Psychol. Bull.*, 1931, 28: 679-680.
47. Mach, E., *The science of mechanics*. 1907, 605 p.
48. McDougall, W., The hormic psychology. In *Psychologies of* 1930, ed. by C. Murchison. Worcester, Mass.: Clark Univ. Press, 1930.
49. McKinney, F., Quantitative and qualitative essential elements of transfer. *J. Exper. Psychol.*, 1933, 16: 854-864.
50. Merkel, J., Die zeitlichen Verhältnisse der Willensthätigkeit. *Phil. Stud.*, 1885, 2: 73-127.
51. Müller, G. E., *Zur Grundlegung der Psychophysic*, 1878, 424 p.
52. Munn, N. L., & Stiening, B. R., The relative efficacy of form and background in a child's discrimination of visual patterns. *J. Genet. Psychol.*, 1931, 39: 73-90.
53. Pavlov, I. P., *Conditioned reflexes*. London: Oxford Univ. Press, 1926, 430 p.
54. Pearson, K., & Heron, D., On theories of association. *Biometrica*, 1913, 9: 159.
55. Poincaré, H., *Science and hypothesis*. New York; Science Press, 1905, 196 p.
56. Rosenbloom, B. L., Configurational perception of tactual stimuli. *Amer. J. Psychol.*, 1929, 41: 87-90.
57. Seward, G. H., Recognition time as a measure of confidence. *Arch. Psychol.*, 1928, no. 99, 54 p.

58. Sherrington, C. S., *The integrative action of the nervous system.* New York: Scribners, 1906, 411 p.
59. Skinner, B. F., The concept of the reflex in the description of behavior. *J. Gener. Psychol.*, 1931, 5: 427-457.
60. Skinner, B. F., The generic nature of the concepts of stimulus and response. *J. Gener. Psychol.*, 1935, 12: 40-65.
61. Spearman, C., *The nature of 'intelligence' and the principles of cognition.* London: Macmillan, 1923, 358 p.
62. Thurstone, L. L., The stimulus-response fallacy in psychology. *Psychol. Rev.*, 1923, 30: 354-369.
63. Thurstone, L. L., *The nature of intelligence.* New York: Harcourt Brace, 1924, 167 p.
64. Titchener, E. B., *A text-book of psychology.* New York: Macmillan, 1910, 565 p.
65. Troland, L. T., *The principles of psychophysiology. Vol. II, Sensation.* New York: Van Nostrand, 1930, 397 p.
66. Warren, H. C., *Human Psychology.* New York: Houghton Mifflin, 1919, 460 p.
67. Warren, H. C., Psychology and the central nervous system. *Psychol. Rev.*, 1921, 28: 249-269.
68. Washburn, M. F., *Movement and mental imagery.* New York: Houghton Mifflin, 1916, 243 p.
69. Watson, J. B., & Watson, R. R., Studies in infant behavior. *Sci. Month.*, 1921, 13: 493-515.
70. Wolfe, W. B., The twilight of psychoanalysis. *Amer. Mercury*, 1935, 35: 385-394.
71. Woodworth, R. S., Dynamic Psychology. In *Psychologies of* 1925. Worcester, Mass.: Clark Univ. Press, 1926.
72. Woodworth, R. S., *Psychology.* New York: Holt, 1934, 546 p.
73. Young, P. T., *Motivation of behavior.* New York: Wiley & Sons, 1936, 562 p.
74. Yum, K. S., An experimental test on the law of assimilation. *J. Exper. Psychol.*, 1931, 14: 68-82.
75. Zangwill, O. L., An investigation of the relationship between the processes of reproducing and recognizing simple figures, with special reference to Koffka's trace theory. *Brit. J. Psychol.*, 1937, 27: 250-276.